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Article :COMPARATIVE STUDY OF PHOTOLUMINESCENCE IN DOPED AND UNDOPED LEAD IODIDE CRYSTALS

A Lead Iodide is a layered semiconductor having the direct band gap 2.55eV with space group D_3d. They consists of molecular sheets, each consisting of a layer cation sandwiched between two layers of hexagonal close packed anion. The forces within a sandwiched are purely ionic in nature, giving a strong binding between an anion and cation layer, whereas the anion layer in adjacent sandwiches are held together by weak van der Waal's forces of attraction. The layers can be stacked in a variety of ways to form different types of polyptism. The most common structure is the 2H hexagonal structure. The band edge optical properties of single crystals have been studied extensively for about 3 decades. I.Ch. Schluter and M. Schluter [1] have reported that the exitonic absorption at the fundamental band edge is cationic with the conduction band states arising predominantly from Pb, 6P atomic orbital, while the valence band states arise from Pb, 6S orbitals. R. Kleim and F. Raga [2], F. Levy et. al.[3] have investigated on luminescence properties at low temperature. M.S. Skolnick and D. Bimberg [4] have reported that in the emission spectrum of lead iodide, recombination of free exitons bound to neutral donars. Besides these, there often appears a band emission in the lower region. Kleim and Raga [2], Bunskil et. al. [5] has reported that the luminescence of Lead Iodide samples prepared by clearing zone-refined crystals consists of a complex emission band.

The single crystals of doped [Al, Cu and Zn with different concentrations] and undoped Lead Iodide crystals have been grown by gel technique. The luminescence have been performed on these crystals at University of Pune, Pune by LS 50 Luminescence spectrometer, Perkin Elemer with pulsed Xenon source, the excitation wavelength is 500nm.

Figures 1, 2, 3 and 4 shows those emission spectra, for doped and undoped lead iodide crystals. In fig.1, the two curves in the order from the top are the spectra of doped (Al with concentration 0.1 and 1M respectively) Lead Iodide crystals. The fig.2 shows the two curves in the order from the top are the spectra of doped (Cu with concentration 0.1 and 1M respectively) Lead Iodide crystals. Fig.3 shows the two curves in the order from top are the spectra of doped (Zn with concentration 0.1 and1M respectively) lead iodide crystals while the fig.4 shows the emission spectra for doped and undoped lead iodide crystals after thermal treatment.

All these fig. shows that the intensities of the doped lead iodide crystals are less than the undoped lead iodide crystals. The two main luminescence band denoted by 'a' and 'b' are remarkably different in the intensities among these crystals. Namely, these intensities strongly depends on the dopant concentration. Kleim and Raja have reported that the luminescence band at 'b' has been assigned to be due to bound excitation while Satoshi et.al. have reported that the luminescence band at 'a' are strongly suggested to originate from the recombination of a D-A pair. This fact is characteristics of the donar acceptor luminescence pair. As seen from fig.4, the peaks of the luminescence bands 'a' and 'b', shift to the higher energy side with increasing dopant concentration. Hence, we conclude that as the dopant concentration increases more D-A pair will be generated after thermal treatment in both doped and undoped lead iodide crystals.

The stacking fault energy is proportional to the square of its slip vectors and the magnitudes of slip vectors depends on the a-dimension of the compound, the X-ray investigaton of these crystals shows that the stacking fault energy of doped lead iodide crystals increases as the dopant concentration increases. Hence, we came to conclusion that there is a inverse relation between stacking fault energy and the intensity of the luminescence.

On thermal treatment for two hours at 373^0 k, fig.4 shows that the intensities of the emission bands decrease for both and undoped lead iodide crystals. Similar results were obtained by I. Baltog et. al. [6]. Storage of the crystals at room

temperature for a couple of weeks after thermal treatment leads to a decreasing of the intensity of the exitonic band and renewed thermal treatment restores the previous intensities.

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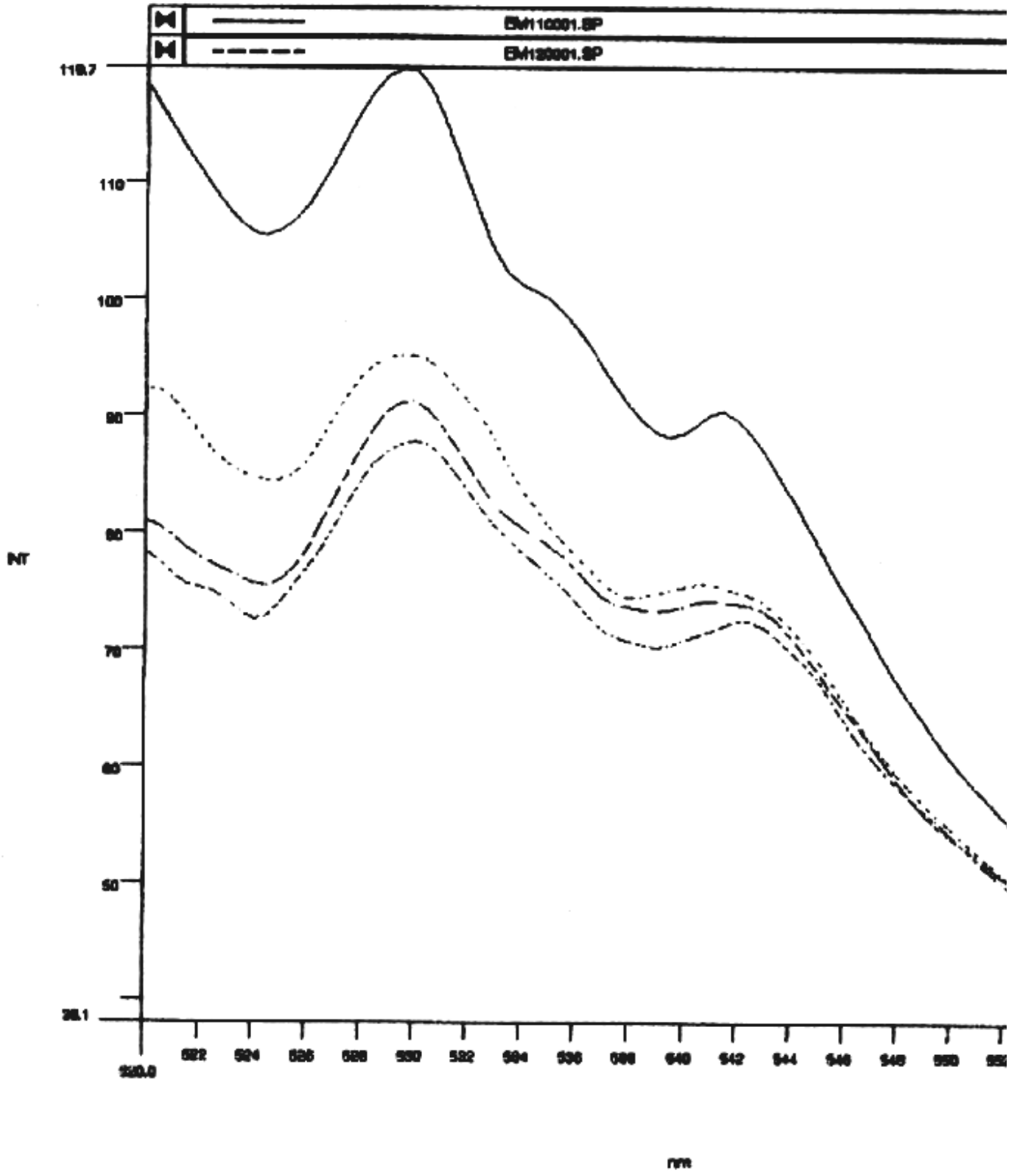
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From bottom: Fig.1,2,3 and 4 respectively